Heterodontus mexicanus, a new horn shark from the Golfo de California [1]

LEIGHTON R. TAYLOR, Jr. [2]

JOSE LUIS CASTRO-AGUIRRE [3]

TAYLOR, JR. LEIGHTON R. & J. L. CASTRO-AGUIRRE, 1972. *Heterodantus mexicanus*, a now horn shark from the Golfo de California. [1] *An. Esc. nac. Cienc. biol., Méx.*, **19**: 123-143.

Fecha de publicación: Febrero de 1972.

SUMMARY: Based on 48 specimens from the Golfo de California, México, a new species of horn shark, *Heterodontus mexicanus*, is described.

It differs from *H. francisci* (Girard), (which is a sympatric species, at least in the southern part of their range), in the low supraorbital ridges which gradually blend into the head profile posteriorely; in *H. francisci* the supraorbital ridges are higher and well developed; *H. mexicanus* has a shallowly concave interorbital area; *H. francisci* has a very concave interorbital area; *H. mexicanus* has a sligthly pointed snout, *H. francisci* has a rounded and relatively short snout; *H. mexicanus* has in the anterior area of the first dorsal fin nearly 125 denticles/cm^2, *H. francisci* has in the same area approximately 200 denticles/cm^2. The most important morphometric difference between two species, is the distance from the snout to the origin of the first dorsal fin (see equations and regression lines in text). The dentary rows of *H. mexicanus* does not show to add tooth-rows with increasing size, *H. francisci* has the inverse tendency. Lenght at hatchling in *H. francisci* ranges from 150-160 mm total length, the single available specimen, (hastchling) of *H. mexicanus* is 140 mm total length. Maximum total length of the 48 specimens of *H. mexicanus* examined in this study was 700 mm compared to 889 mm for 106 specimens of *H. francisci*. Length of males at sexual maturity (as evidenced by the relative length of the claspers) is 550 mm or less in *H. mexicanus* the first dorsal fin is higher and the pectorals longer than in specimens of same size of *H. francisci*.

INTRODUCTION

Seven extant species of the monogeneric family heterodontidae are known from the East and West Pacific Oceans, Australasia, and the Indian Ocean. The greatest concentration of species occurs in the eastern Pacific region and inclu-

---

[1] Contribution from the Scripps Institution of Oceanography, University of California, San Diego (La Jolla, California 92037), U. S. A.

[2] Scripps Institution of Oceanography, Marine Biology, La Jolla, California 92038, U. S. A.

[3] Department of Zoology of the Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional, Apdo. Postal No. 42-186, México 17, D. F.

des: *Heterodontus francisci* (Girard), from California and the Golfo de California, México; *H. quoyi* (Freminville), from the Galapagos Islands, and the Peruvian *H. peruanus* (Evermann and Radcliffe) which Beebe and Tee Van (1941) synonymized with *H. quoyi*. The new species described herein raises the total number of eastern Pacific species to four. It is apparently sympatric with *H. francisci* throughout most of its range.

The heterodontid shark figured in Kumada and Hiyama (1937, pl. 46, p. 16) as *Gyropleurodus* (= *Heterodontus*) *peruanus* Evermann and Radcliffe is probably *H. mexicanus* sp. n. This is indicated by the low supraorbital ridges and the relatively shorter distance from snout to D_1 origin. The exact collection-locality of this specimen is not recorded and it has been assumed to be from "somewhere along the west coast of Mexico" (Beebe and Tee Van 1941, p. 119). However it was probably caught within the Golfo de California since Kumada and Hiyama also record species endemic to this area (e. g. *Cynoscion macdonaldi* Gilbert). It should also be pointed out that the egg-case which Beebe and Tee Van collected at Arena Bank, Golfo de California (p. 120, fig. 31) and which they refer to *H. quoyi*, is probably referable to *H. mexicanus*. The ridged flanges and tentacles illustrated and discussed by Beebe and Tee Van are identical with those found in the egg-case herein attributed to *H. mexicanus* (Fig. 5).

Material and Methods

Specimens deposited at the following institutions were examined: Scripps Institution of Oceanography (SIO), University of California at Los Angeles (UCLA), and Los Angeles County Museum of Natural History (LACM). Projection measurements listed in Table 1 and given in the description were made in the manner of Bigelow and Schroeder (1948). Measurements bearing an asterisk in Table 1 were made on a sliding-scale measuring table similar to that described by Hiatt and Hamre (1945); the remainder were made with dial calipers. The distance from the origin of the second dorsal fin to the anal origin was calculated by subtracting the distance between the snout-tip and the second dorsal origin from the distance between the snout-tip and the anal origin.

The following abbreviations are used: TL, total length; HL, head length; SL, snout length; D_1, first dorsal fin; D_2, second dorsal fin; P_1, pectoral fin; P_2, pelvic fin; and A, anal fin. "Origin" is used to mean the anteriormost point at which a fin-margin meets the main profile of the body; "insertion" refers to the posteriormost point at which a fin-base is attached to the body.

Counts of vertebral centra were made from radiographs. Monospondylous counts are least subject to error; diplospondylous counts are less accurate due to difficulty in ascertaining the exact origin of the caudal fin. Caudal vertebrae are not recorded because the small, often poorly calcified terminal centra are usually obscured by dermal denticles and an accurate count it not possible. Also recorded are the number of monospondylous centra between the origin of the vertebral column and the insertion of the first dorsal spine and the number of diplospondylous centra between the transition from monospondyly and the insertion of the second dorsal spine. In both cases, the spine directly overlies the vertebral column and the first centrum with at least one-half its length under the spine is counted as the insertion-centrum.

Counts of tooth-rows were made from 21 sets of jaws dissected from specimens ranging from 158-680 mm TL. Comparative material of *H. francisci* included 38 dissected jaws from specimens 160-800 mm TL.

Heterodontus mexicanus sp. nov.

(Fig. 1)

Gyropleurodus peruanus: (not of Evermann and Radcliffe) Kumada and Hiyama 1937: 16, pl. 46. (Figure and description).

Heterodontus peruanus: (not of Evermann and Radcliffe) Beebe and Tee Van 1941: 119-120, fig. 31 (Figure and description of egg-case).

DIAGNOSIS. This species is distinguished by having low supraorbital ridges which gradually blend into the head profile posteriorly, a shallowly concave interorbital area, a slightly pointed snout, large denticles, numerous large black spots covering the dorsal body surface, a faint white bar across the interorbital area, and an egg-case with ridged flanges and tendrils.

DESCRIPTION. Head moderately depressed with ventral surface flattened, its length about 4-5 in total length; supraorbital ridges low, equal in height for most of their length, gradually joining head profile posteriorly. Interorbital area only slightly concave, interorbital distance 2.5 in head length; snout relatively elongate and pointed, its length about 2-3 in head length. Maximum internarial distance about 2.5-3 in head length; proximal anterior margin of nostril expanded as a flap; shallow groove along distal margin of nostril; oronasal groove present. Mouth length about 4.5 in head length; mouth width about 2 in head length; margin of lower jaw with thick labial lobes lying at rigth angles to midline of body.

Number of teeth variable: total in upper jaw 19-25 in adults; number of molariform teeth varying from 4-5 on each side, raptorial teeth 4-5 on each side; tooth-row in jaw symphysis present or absent, total teeth in lower jaw 15-21, 3-5 molariform, 2-4 raptorial; usually a tooth-row in symphisis. Molariform teeth with a strong ridge along crest of long axis. Specimens less than 200 mm with all teeth similar, each tooth with 8-9 strong cusps.

Eye moderately large and oval, its major axis 6-7 times in HL; spiracle small and pore-like, located below posterior corner of eye about one-third eye diameter from ventral margin of orbit. Distance from snout to spiracle about 2 in head length. Gill-slit I highest of the five, about 4.3 in head length, the height of each slit decreasing posteriorly with V about one-half the height of I. Gill-slit III over pectoral origin; distance from snout to gill-slit I about 6 in total length. Distance to P_1 origin about 4-5 in TL, this origin well ahead of D_1 origin. Pectoral fins moderate in size, maximum length less than head length, pectoral base 2.5-3 in head. Pelvic origin sligthly behind free end of D_1; distance from snout to P_2 origin 2.2-2.5 in total length. Pelvic base almost 3 in head length, extreme tip of fin barely extending to D_2 origin. In mature males that portion of pelvic clasper extending beyond free margin of fin is equal in length to entire pelvic fin.

D_1 larger than D_2, its height (from posterior insertion to extreme tip) about 10 in total length. D_1 origin behind middle of pectoral base but ahead of pectoral fin insertion; snout to D_1 origin 3.5-4 times in total length. D_2 height 18 times in total length; origin behind trailing edge of pelvic fins; distance from snout to D_2 origin about 1.7 in total length. Distance to anal origin about 1.4-1.6 in total length; anal fin small, base about 4 in head length; anal origin slightly ahead of extreme rear tip of D_2; trailing edge of anal opposite origin of lower caudal lobe.

COLORATION. Ground color of fresh specimens a greyish-brown with slight bronze iridescence, ventral surfaces of body and fins pale whitish-grey. Both fresh and preserved specimens with pale bar across the top of the head connecting the posterior ends of supraorbital ridges. This bar accentuated by diffuse blackish areas in front and behind. A similar but less obvious bar connects anterior parts of supraorbital ridges. Dorsal surfaces of body, paired fins, and caudal and dorsal fins often with large black spots (about one-half eye diameter). Number of spots varying widely between individuals. Top of head and snout rarely spotted. Ventral surfaces of body pale cream to white, rarely with black spots, which are smaller than those on flanks and back. A pale area often extending up sides of body almost to midline in area between P_2 base and caudal origin; a less extensive pale area usually found on lower sides of belly area between P_1 insertion and P_2 origin.

Body and fin surfaces covered with denticles, typically cross-shaped and large, causing skin surface to be coarse and rough to the touch; area behind D_1 with 70-130 denticles/cm^2 in adults. Total precaudal vertebrae 60-70 $(\overline{x} = 64.2)$ monospondylous 30-34 $(\overline{x} = 30.9)$ diplospondylous 30-38 $(\overline{x} = 33.3)$ dosal spine I inserted over 14th-16th $(\overline{x} = 14.9)$ monospondylous vertebra, dorsal spine II inserted over 9th-14th $(\overline{x} = 11.9)$ diplospondylous vertebra.

Egg-Case (Figs. 5, 6)

Three heterodontid egg-cases trawled from 55-73 m in Bahía de la Paz, Baja California Sur, México (SIO 65-257) are strinkingly different from those of *H. francisci* and are attributed to *H. mexicanus*. Both types are ovately spheroid with a double row of ridges spiralling around the case giving it the appearance of an augur. In egg-cases of *H. francisci* these ridges are simple, thin, and without flanges; in contrast the *mexicanus* type has fairly thick ridges which bear wide flanges lying in a plane parallel to the midline of the case. The tip of the case also bears a pair of tendrils which exceed one-half the length of the entire case. Such tendrils are lacking in cases of *H. francisci* (Fig. 6). (These tendrils have broken off the case illustrated in Fig. 5 but fragments of the other cases in SIO 65-257 bear complete tendrils). The cases of *H. mexicanus* are also smaller; the maximum length of the two remaining intact cases are 78 and 83 mm. Cases of *H. francisci* are usually over 100 mm in longest dimension.

Four months after collection a 140 mm TL female hatched from one of the egg-cases which had been maintained in an aquarium. The hatchling died a short time later and was preserved for study. Characteristics of this specimen confirm the suspicion that the egg-cases were laid by and individual of *H. mexicanus.*

Although the egg-case of *H. mexicanus* is quite different from that of *H. francisci*, it is strikingly similar to that of *H. quoyi* as described in Tortonese (1939. p. 2) and illustrated in Orces (1951, p. 74, Fig. 1). Both types share the characteristics of smaller size (64 mm in Tortonese's specimen and 84 in Orce's), flanged ridges, an double tendrils on the pointed end. (It should be noted that Tortonese described the case as having four tendrils in his 1939 paper but corrected this erroneous statement in 1951).

Material Examined

Holotype. SIO 70-90. A 610 mm TL female collected near Cerro Colorado. Sonora, México by a Mexican shrimp trawler in about 20 m depth on 25 March. 1970 and obtained for study by an SIO-UCLA joint collecting party. Paratypes Golfo de California, SIO 59-101, 9(482-700) near San Felipe, Baja California; UCLA 52-45, 1(358) off Punta Fermín, Baja California; SIO 62-236, 2(550-557) Bahía de Los Angeles; LACM 8825, 2(525-635) Bahía de Las Animas; SIO 65-305, 2(502-506) Bahía Santa Inez, SIO 65-257, 1(140) and 2 egg-cases, Bahía de La Paz; SIO 65-250), 1(611) Canal de Cerralbo; SIO 60-112, 1(494) near Bahía Kino; SIO 69-315, 1(593) near Punta Kino; SIO 70-90, 18(355-641) near Cerro Colorado, Sonora; LACM 6552, 1(303) Los Cocos, Sinaloa; UCLA 50-43, 3(276-328), Sonora; LACM 6552, UCLA 58-46, 2(569-599) S. of Bahía Topolobampo. Outer coast of Baja California: SIO 64-19, 1(663) and UCLA 55-95, 1(521) Bahía Magalena.

Derivation of Name

Named *mexicanus* for the country to whose coastline the species is apparently endemic.

Range (Fig. 3)

H. mexicanus occurs within the Golfo de California on both shorelines and is also known from Bahía Magdalena on the outer coast.

Identification of Juveniles

Identification of sub-adults (> 400 mm) becomes increasingly difficult with decreasing size. Complete treatment of this problem is not possible at present due to the lack of specimens of both species within the 175-275 mm size-range which prevents the evaluation of diagnostic characters for individuals of these lengths. It is possible that identification migth be difficult for this size-class.

The following discussion is based on 1 hachling and two 165 mm specimens of *H. mexicanus* and over 25 hatchlings, and one 276 mm TL juvenile of *H. francisci*. The adult diagnostic characters are so obscured in juveniles that they are of little use in the smallest specimens. In juveniles of both species the supraorbital ridges are high, the denticles are coarse, and the dark body markings are similar in size.

However there are trenchant differences between juvenile specimens of both species which are not found in adults. All specimens of *H. mexicanus* have a much higher firts dorsal fin (5 in TL compared to in TL) and much longer pectoral fins (exceeding the HL in *H. mexicanus* but shorter than HL in *H. francisci*). In addition, the tip of the anal fin falls short of the lower caudal origin in *H. mexicanus*, but it meets or exceeds it in *H. francisci*.

Both species share the ontogenetic changes in dentition which are characteristic of the family Heterodontidae. That is, in the young stages all teeth in the jaw are similar and multicuspid. With maturity, the lateral teeth lose their sharp cusps and become molariform, while the front teeth change to the adult tricuspid configuration with a long central cusp and subordinate side cusps about 1/3 to 1/5 as long. In individuals up to 200 mm TL the teeth bear 8-9 cusps in *H. mexicanus* and 7 or less in *H. francisci*. In specimens greater than 300 mm TL, the transition to the adult tooth-type is well begun and this character is no longer useful.

Comparison of *H. mexicanus* and *H. francisci*

The ranges of *H. mexicanus* sp. n. and *H. francisci* (Girard) overlap in the Golfo de California and at Bahía Magdalena. The two species were taken together in four of twenty-two collections examined from these areas.

However collection records are not sufficiently detailed to allow inferences about ecological differences.

The two species are distinguished as adult using those characters outlined in the diagnosis. Smaller specimens become increasingly difficult to identify as they decrease in size; characters used in distinguishing juveniles are discussed in the section "Identification of Juveniles".

Counts of Vertebral Centra

Although all of the various counts of vertebral centra overlap in range, four of the five are significantly different at the .05 level of probability when the means are compared. These data are summarized in Table 2. Only the means for D_1 spine-centra do not differ significantly. It should be noted that magnitude of the coefficients of variability are quite similar in the two species. The most variable count in each is the number of D_2 centra which has a coefficient of variability exceeding 10 in both species, compared with less than 6 in the other, less variable counts.

Morphometric Characters

Both species are strikingly similar in almost all of the morphometric characters investigated as shown in Table 1. In addition there is a good deal of variability present within a species for any given measurement. This precludes the effective use of morphometry for the identification of individual specimens. The most striking morphometric difference between *H. mexicanus* and *H. francisci* is summarized in Fig. 4 in which the distance from snout to D_1 origin is plotted against the distance from D_2 origin to anal origin (measured as a projection). The two regression lines were calculated using the Bartlett method (Simpson, Rowe, and Lewontin 1960: 230-238); the 95% confidence limits for the lines are not illustrated but overlap only for specimens smaller than 200 mm TL, or 60 mm snout-to-D_1-length. The regressión equations were calculated to be $Y = 0.227X + 8.404$ for *H. mexicanus*, and $Y = 0.418X + 6.520$ for *H. francisci.*

Denticles

Dermal denticles of both species are of the typical heterodontid type: sessile, flattened, and shaped like a maltese cross when viewed from above. This general shape may vary over the body and fins with the center of the cross elevated on most dorsal body surfaces but quite flattened on the ventral surfaces. In those areas where the skin surface commonly is abraded by the substrate, such as mots of the ventral surfaces, and the snout, the denticles are worn down into a pattern resembling street- cobbling. The denticles are constantly being replaced and representatives of all sizes are evident in any given area.

H. mexicanus generally seems to have somewhat larger, less densely distributed denticles. This gives the surface of adult a much coarser appearance than in *H. francisci* in which the denticles are smaller and closer together. This is a difficult character to quantify owing to the continual introduction of new denticles independent of the total length of the individual. However the maximum size of denticles appears larger in *H. mexicanus.* Ten specimens of *H. mexicanus* had less than 125 denticles/cm^2 in the area immediately anterior to D_1 compared to over 200 denticles/cm^2 in ten specimens of *H. francisci.*

Teeth

Dentition in both species is similar: the front teeth are tricuspid with the central cusp the longest; a few rows of transitional teeth separate these raptorial teeth from the molariform teeth of the sides of the jaw. In both *H. mexicanus* and *H. francisci* these elongate, rounded, grinding-teeth bear ridges on their surfaces extending for the length of the crown. The presence of "carinate lateral teeth" (referring to this ridge or keel) was used by Regan (1908: 494) and

Gill (1862: 489) as a character in defining various generic and subgeneric groupings within the Heterodontidae. The condition is contrasted with the smooth rounded lateral teeth found in *H. japonicus* Maclay and Macleay and *H. portusjacksoni* (Meyer). These subdivisions are not recognized herein.

The number of tooth-rows is variable within each species and their ranges overlap thus precluding the use of tooth-numbers in the distinguishing of species. Total number of tooth-rows in 14 adult *H. mexicanus* ranged from 34-44 with a mean of 39, compared to 37-52 in 35 *H. francisci* with a mean of 43. A t-test of the two means showed no significant difference between them at the .05 level of probability.

The most striking difference in dentition is the general tendency for *H. francisci* to add- tooth-rows with increasing size (Fig. 7) and the contrasting smaller correlation between total length and toot-numbers in *H. mexicanus* (Fig. 8). The correlation coefficients for total length and total tooth rows in *H. mexicanus* and *H. francisci* are .66 and .90 respectively.

Size

H. mexicanus appears to be a generally smaller species than *H. francisci*. Length at hatching in *H. francisci* ranges from 150-160 mm; the single available hastcling of *H. mexicanus* is 140 mm TL. Probably correlated with small hatching-size is the smaller egg-case size in *H. mexicanus*. Maximum lengths of the two cases available for study are 75 and 84 mm; egg-cases of *H. francisci* range from 104-123 mm and average 111 mm.

Maximum total length of the 48 specimens of *H. mexicanus* examined in this study was 700 mm, compared to 889 mm for 106 specimens of *H. francisci*. Length of males at sexual maturity (as evidenced by the relative length of the claspers) is 550 mm or less in *H. mexicanus* and 600 mm or more in *H. francisci* (Fig. 9).

Resumen

Del estudio de 48 ejemplares colectados en el Golfo de California y en Bahía Magdalena, costa occidental de Baja California se describe el tiburón-gata *Heterodotus mexicanus* sp. nov.

Difiere de *H. francisci* (Girard), especie simpátrica de *H. mexicanus*, por las siguientes características: Crestas supraorbitales muy bajas en comparación con *H. francisci*, en el cual dichas estructuras están bastante desarrolladas y altas; *H. mexicanus* presenta un área interobital ligeramente cóncava, en tanto que en *H. francisci* dicha superficie es muy cóncava; en *H. mexicanus* el hocico es más aguzado que en *H. francisci*, en el cual tanto el hocico como el morro son redondeados y cortos; *H. mexicanus* presenta, en el área inmediata anterior a la primera aleta dorsal, alrededor de 125 dentículos dérmicos/cm^2. La característica morfométrica más importante entre las dos especies es la distancia que existe desde el hocico al origen de la primera aleta dorsal (ver ecuaciones y líneas de regresión en el texto). En *H. mexicanus* al aumentar el tamaño no aumentan

las filas dentarias, mientras que en *H. francisci*, al aumentar el tamaño se presenta un aumento de filas dentarias. Al nacer *H. mexicanus* mide alrededor de 140 mm de longitud total, en tanto que *H. francisci* mide de 150 a 160 mm de longitud total. Aparentemente, la longitud máxima de *H. mexicanus* es de 700 mm, en tanto que en *H. francisci* es de 889 mm. Los huevos de *H. francisci* son mayores que los de *H. mexicanus*. La madurez sexual es alcanzada por *H. francisci* a los 600 mm o más y en *H. mexicanus* a los 550 mm o menos. En los ejemplares juveniles de *H. mexicanus* la primera aleta dorsal es más alta y las pectorales más grandes que en individuos de la misma edad de *H. francisci*.

DIAGNOSIS. Crestas supraorbitales bajas; área interorbital muy ligeramente cóncava; hocico algo aguzado; dentículos dérmicos grandes; muy numerosas manchas negras y grandes aproximadamente circulares en la superficie dorsal del cuerpo; una barra blanquecina en el área interorbital; huevos con crestas espiraladas y prolongaciones filiformes en su ápice.

Literature Cited

BEEBE, W. & J. TEE-VAN, 1941. Eastern Pacific expeditions of the New York Zoological Society XXV. Fishes from the tropical eastern Pacific. Part 2: Sharks. *Zoologica*, N. Y., **26**(2): 94-122.

BIGELOW, H. B. & W. C. SCHROEDER, 1948. Sharks. In: Fishes of the Western North Atlantic. *Mem. Sears Foundation fo Marine Res.* Part 1, **1**: 59-576.

EVERMANN, B. W. & L. RADCLIFFE, 1917. Fishes of the west coast of Peru and the Titicaca Basin. *Bull. U. S. Nat. Mus.* **95**: 1-166.

FREMINVILLE, M., 1840. Notice sur une nouvelle espéce de poisson appartenant au genre *Cestracion* de Cuvier. *Mag. Zool.* **2**, ser. 2: 1-3.

GILL, T., 1862. On the classification of the families and genera of the Squali of California. *Proc. Acad. Nat. Sci. Phila.* **14**: 483-501.

GIRARD, C., 1854. Characteristics of some cartilaginous fishes of the Pacific coast of North America. *Proc. Acad. Nat. Sci. Phila.* **7**: 196-197.

HIATT, R. W. & C. J. HAMRE, 1945. A device for measuring fish. *Jour. Wildlife Mgt.* **9**(1): 79-81.

KUMADA, T. & Y. HIYAMA. 1937. Marine fishes of the Pacific coast of Mexico. Nissan Fish. Inst. and Co. Ltd. Odawara, Japan. pp. 1-75. pls. 1-102.

MACLEAY, N. DE MIKLOUHO & W. MACLEAY, 1884. Plagiostomata of the Pacific. Part 2. *Proc. Linn. Soc. N. S. W.* **8**(1883): 426-431.

MEYER, F. A. A., 1793. Systematisch-Summarische ubersicht der neuesten Zoologischen Entdeckungen in Neuholland uud Afrika. Leipzig.

ORCÉS, G., 1959. Peces marinos del Ecuador que se conservan en las colecciones de Quito. *Ciencia y Naturaleza* **2**(2): 72-91. Quito, Ecuador.

REGAN, C. T., 1908. A synopsis of the sharks of the family Cestraciontidae. *Ann. Mag. Nat. Hist.* ser. 8, **1**: 493-497.

SIMPSON, G. G., A. ROWE & R. C. LEWONTIN, 1960. Quantitative Zoology. Harcourt Brace, N. Y. 440 pp.

TORTONESE, E., 1939. Su alcuni Plagiostomi e Teleostei raccolti dal dott. E. Festa nell' America centrale e meridionale. *Boll. Mus. Zool. Anat. Comp. del Univ. Torino* **47**, ser. 3, (89): 1-14.

—— 1951. Materiale per lo studio sistematico e zoogeografica dei pesci delle coste occidentali de Sud America. *Rev. Chile. Hist. Nat.* años 51-53 (1947-1949): 83-118. Santiago, Chile.

FIG. 1. Holotype of *Heterodontus mexicanus*, SIO 70-90; 610 mm TL.

FIG. 2. Dorsal view of head of holotype showing the relatively pointed sonut and white bar connecting the posterior ends of the supraorbital ridges.

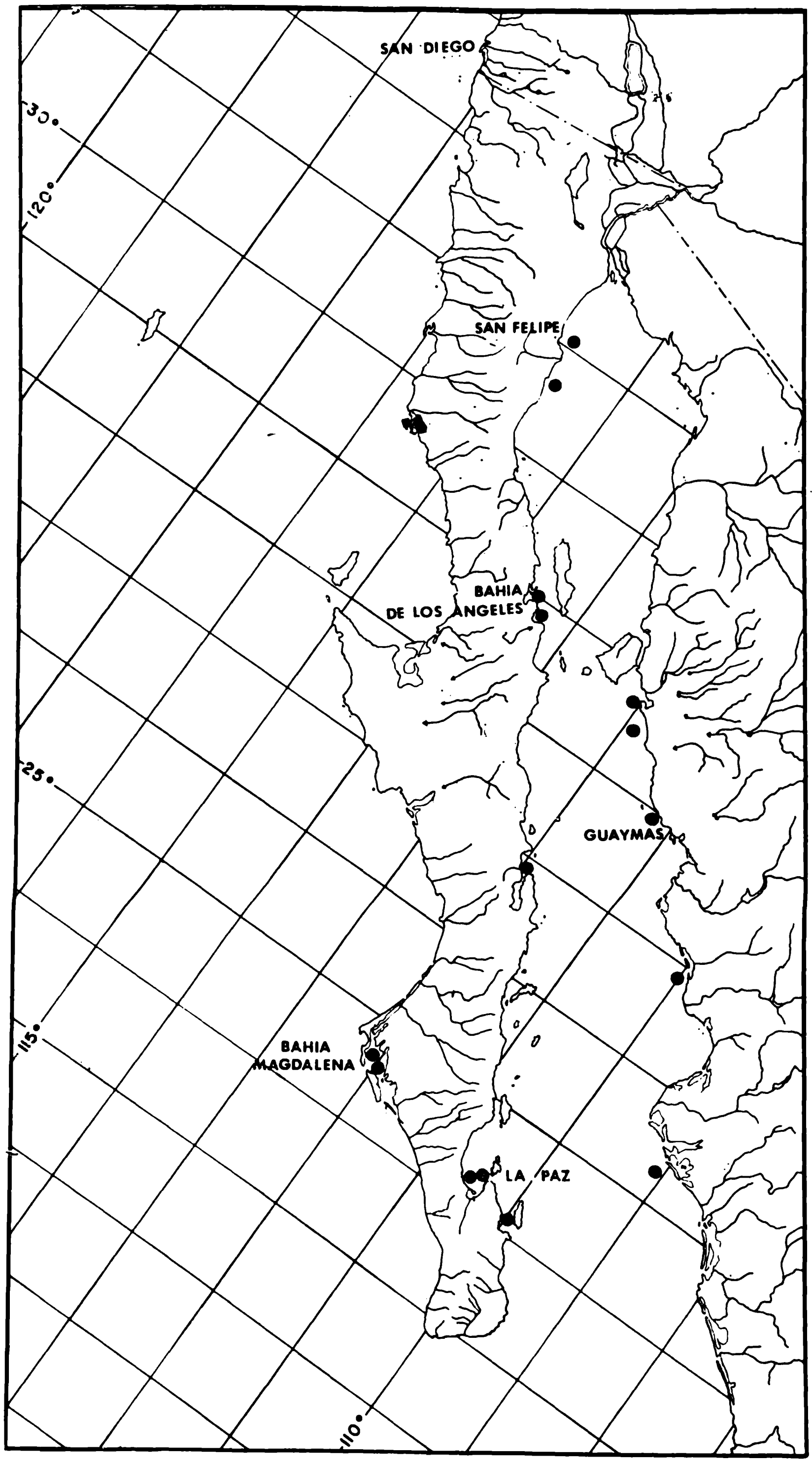

FIG. 3. Golfo de California, México. Black dots indicate collection-localities of specimens of *H. mexicanus* examined in this study.

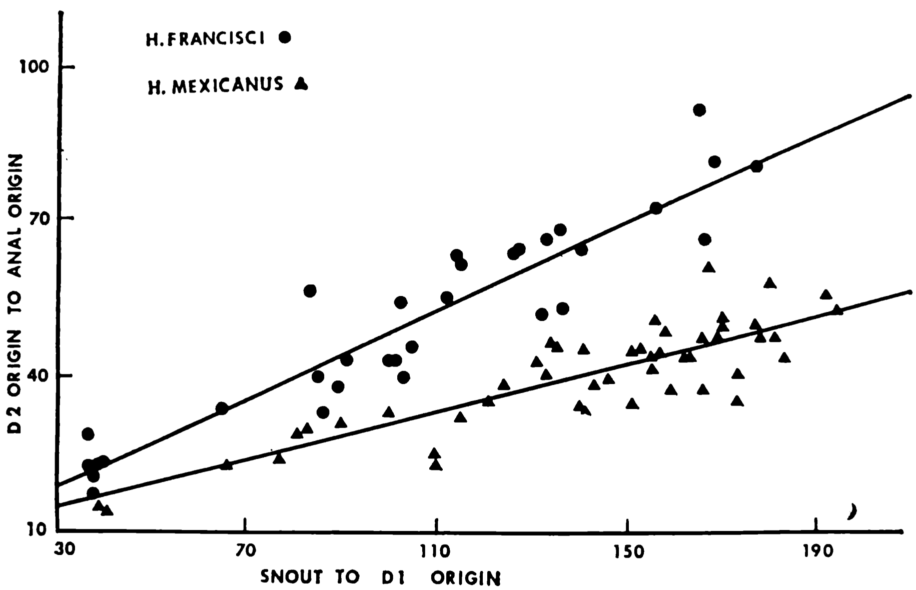

FIG. 4. Regressinn lines of *H. francisci* (dots) and *H. mexicanus* (triangles): distance between D_2 origin and anal origin against distance between snout tip and D_1. Note signi ficant difference between slopes.

FIG. 5. Egg-case of *H. mexicanus*, SIO 65-257, from Bahía La Paz, México; about 83 mm in length (tendrils broken).

FIG. 6. Egg-case of *H. francisci*, SIO 50-257, from Laguna San Ignacio, México; about 104 mm in length.

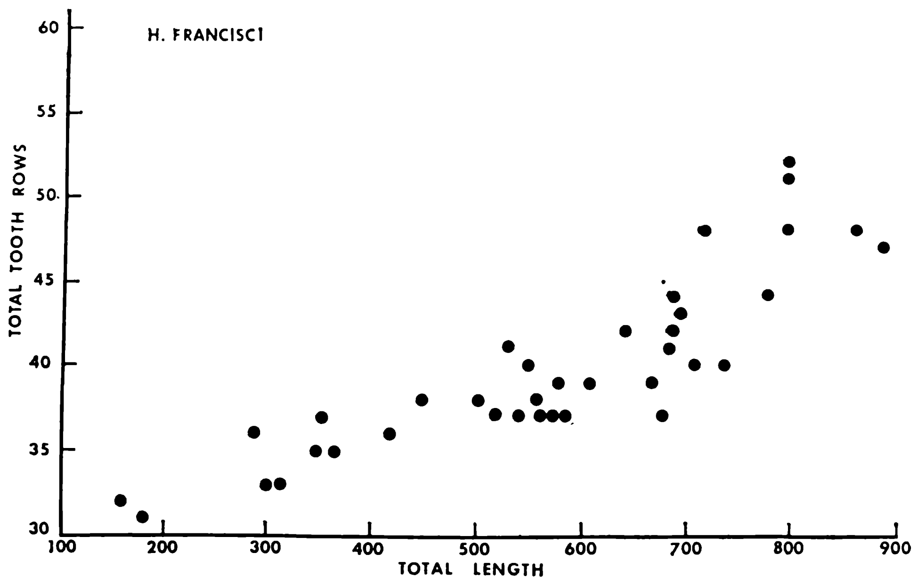

FIG. 7. Scatter diagram for *H. francisci*: total length against total number of tooth rows.

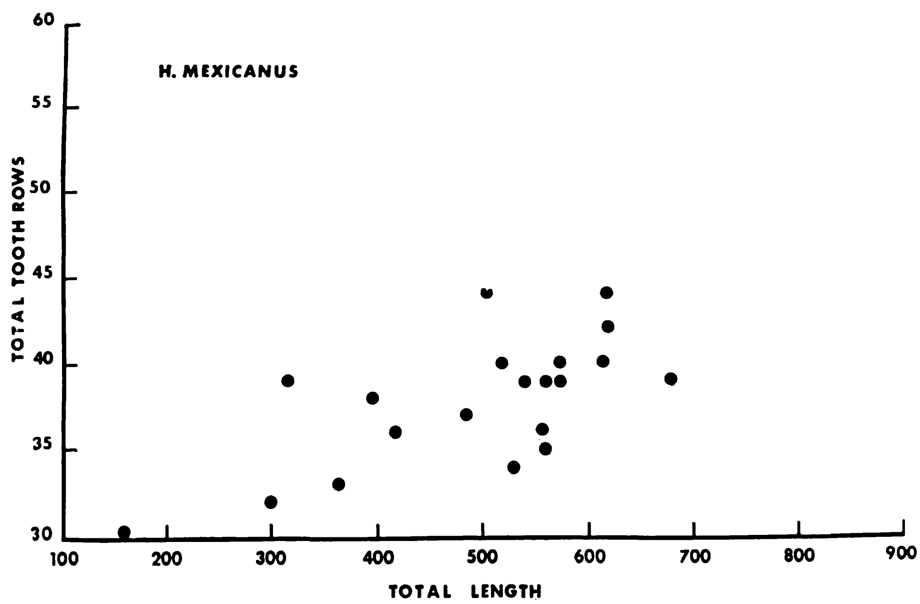

FIG. 8. Scatter diagram for *H. mexicanus*: total length against total number of tooth rows. Correlation coefficient = 0.66.

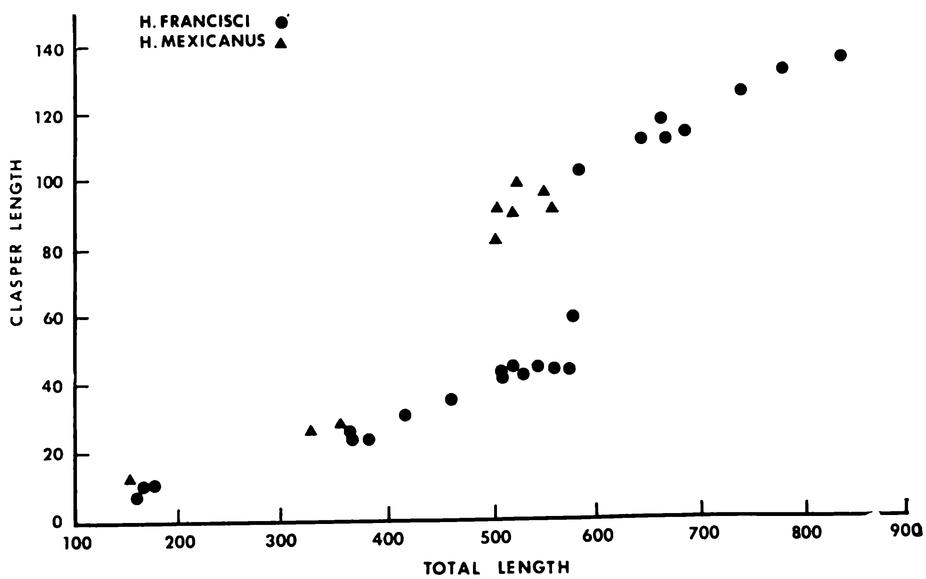

FIG. 9. Scatter diagram for males of *H. francisci* (dots) and *H. mexicanus* (triangles): total length against clasper length. Sexual maturity is assumed to occur at the disjunction. Note smaller size at sexual maturity in *H. mexicanus*.